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REMARKS

By this amendment, claims 8-12 are canceled, claims 7, 17, and 18 are amended, and claim 21 is added. No new matter has been entered. Accordingly, claims 1-7, and 13-21 are pending in this application.

Objection to the claims

The examiner has objected to claim 17 on the basis of being non-definitive. Such an objection has been overcome by the above amendment to claim 17.

§112 Rejections

In the Office Action, claims 14-18 are rejected under 35 USC 112, first paragraph, as failing to comply with the written description requirement. We traverse this rejection and wish to point out to the examiner that the support for the cited limitation at issue is provided for by comparing FIG. 4A and its associated written description with FIG. 4B and its associated written description. In particular, page 10, line 5 - page 11, line 2 of the specification states the following (*emphasis added*):

> Figure 4A illustrates standard self aligned source 400 doping after source implant and re-oxidation. Figure 4A is prior art. The source doping takes place at 403. The horizontal surfaces 402 are heavily doped and the vertical surfaces 401 are lightly doped. *The resistance of the self aligned source 400 is a function of the dopant atom concentration of along it. Because of steep profiles formed during shallow trench isolation processes, the concentration of dopant atoms along the self aligned source is not uniform. Atoms implanted in the steep slope or vertical surfaces 401 have a lower effective concentration due to the nature of the implant process. This decrease in concentration along the vertical surfaces 401 of the self aligned source, leads to higher than expected self aligned source resistance. This problem increases as the depth of the shallow trench increases and this is one of the limiting factors for increasing the trench depth.*
>
> Figure 4B illustrates self aligned source 400 doping according to one embodiment of the invention. Figure 4B is prior to re-oxidation and after source implants 403 and phosphorus doped oxidation 404 and etching. Phosphorus doped oxide has been removed from the horizontal surfaces 402 so that the phosphorus doped oxide 404 only remains on the vertical surfaces

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> 401. Figure 4C illustrates self aligned source 400 doping according to one embodiment of the invention. Figure 4C is the self aligned source of figure 4B after re-oxidation. The vertical surfaces 401 have increased doping from phosphorus diffusing out of the phosphorus doped oxide 404. Thus, the vertical surfaces 401 and horizontal surfaces 402 are more evenly doped than the respective surfaces of figure 4A. *Furthermore, by supplying an additional source of dopant directly to the vertical surfaces 401, the overall self aligned source resistance can be improved. The rail resistance limiting factor for trench depth can be greatly reduced or eliminated.*

Accordingly, the applicants assert that the limitation in independent claim 14 of "said self align source having a resistance less than a self aligned source without the vertical phosphorous-doped oxide layer, thereby permitting a trench depth deeper than the self aligned source without the vertical phosphorous-doped oxide layer" is stated in the specifications in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time of the application was filed had possession of the claimed invention. Withdrawal of this §112 rejection is respectfully respected.

Additionally, claim 18 is rejected under 35 USC §112, second paragraph for the reason noted in the Office Action. This rejection has been overcome by the above amendment to claim 18.

§103 Rejections

Claims 1-4 are rejected under 35 USC 103(a) as being unpatentable over Takahashi et al. (US 6,657,893) in view of Wu (US 6,649,308) and Colabella (US 6,252,274). Claim 5 is rejected as being unpatentable over Takahashi et al. in view of Wu and Colabella, as applied to claims 1-4, and further in view of Bergemont et al. (US 5,856,222). The applicants respectfully traverse these rejections for the following reasons.

In our view, it would not have been obvious at the time the invention was made to a person of ordinary skill in the art to have modified Takahashi et al. in view of Wu and Colabella to arrive at the claimed subject matter. In that regard, the invention when considered "as a whole" as required by 35 U.S.C. § 103 is not suggested by the applied prior art.

Applicants maintain from the previous office action response that in addition to failing to disclose and suggest self-aligned source (SAS) regions and the presence of a phosphorous-doped oxide along the vertical edges of the gate stack, Takahashi et al. also fail to disclose or suggest "a first oxide layer deposited over the substrate stretching from the drain to the self-aligned source," as recited by claim 1.

Applicants note that the section in Takahashi et al. at column 21, lines 51-54, that is asserted by the examiner as teaching the above noted limitation, is in fact an intermediate process step. If one skilled in the art was to use the structure of Takahashi et al. at the point where the field oxide is a single insulating film as asserted by the examiner, then the structure would also lack source and drain regions as Takahashi et al. teach doping the drain diffusion layer 8, the source diffusion layer 9, and the intermediate diffusion layer 10 at the same time. See col. 21, lines 56-59. One skilled in the art would recognize that in order to form diffusion layers 8, 9, and 10 at the same time, at some point in the process of Takahashi et al. the insulating film and remaining layers provided thereon must be etched, thereby forming the pair of transistor gates, so to expose the diffusion layers 8, 9, and 10 to dopant implantation. At that point and as explicitly disclosed by Takahashi et al. "drain diffusion layer 8 is provided adjacent to the memory transistor, the source diffusion layer 9 is provided adjacent the select transistor, and the intermediate layer 10 is provided between the memory transistor and the select transistor." Col. 21, lines 31-36. Hence the oxide layer in Takahashi et al. never stretches from the source region to the drain region, unlike it has been asserted by the examiner.

When the other parts necessary for the full appreciation of what Takahashi et al. fairly suggest to one of ordinary skill in the art is considered, it is evident that the structural elements present in independent apparatus claim 1 differentiate the claimed invention from the apparatus disclosed in Takahashi et al. as stated above. Accordingly, combining the self-aligned source of Colabell, and the phosphorous-doped oxide spacers of Wu with a transistor of Takahashi et al. (even though no such motivation is provided), would fail to produced the claimed invention as "a first oxide layer deposited over the substrate stretching from the drain to the self-aligned source," as recited by claim 1 would be missing.

Applicants reiterate that in deciding the question of obviousness under 35 U.S.C. §103, it is not realistic to pick and choose from any one reference only so much of it as will support a

given position, to the exclusion of other parts necessary to the full appreciation of what such references fairly suggests to one of ordinary skill in the art. *In re Wesslau*, 353 F.2d 238, 241, 147 USPQ 391, 393 (CCPA 1965); see also *In re Mercer*, 515 F.2d 1161, 1165-66, 185 USPQ 774, 778 (CCPA 1975). The mere existence in the prior art of individual elements of applicants' invention does not, without more, render the claimed invention prima facie obvious under 35 U.S.C. §103. Instead, there must be evidence that the bringing together of such elements would have been prima facie obvious to a person of ordinary skill in the art.

Without excluding the remaining sections of the cited reference, one skilled in the art would clearly understand that the intentions of Takahashi et al. is to provide an intermediate region 10 between a memory transistor (the "Memory Tr") and a Select transistor (the "Select Tr"), wherein the drain 8 is provided adjacent the memory transistor and the source is provided adjacent the select transistor as depicted in FIG. 1. For that reason, extending the first oxide layer from the drain to the self-aligned source, such as disclosed by Colabella, in order to produce this limitation of the claim 1 would render the device of Takahashi et al. inoperable for its intended purpose. None of the other cited references would cure this deficiency in the combination of references.

Additionally, one skilled in the art is not provided with the motivation to combine the teachings of Takahashi et al. and Colabella. As stated in the previous response, Colabella is directed to addressing the problem of the leakage current 15 flowing beneath the bit line between the source line 10 and the drain line 17 of a CHE type flash EEPROM, and not a FN-FN type flash EEPROM as in the case of Takahashi et al. See Fig. 2B and note that the source region is deeper than the drain region. To address the above problem, Colabella teaches the steps of providing a 585 mask for the P ands As source implantation, removing the 585 mask, and then performing a later As source and drain implantation. See col. 5, lines 33-39. Accordingly, the source and drain of Colabella after the SAS process are not symmetrical. Please note that the region denoted with the symbol C in FIG. 2 illustrates one of many source active regions that is not covered by mask 585, and that the region denoted by symbol D is one of many drain regions that is covered by the mask. Colabella specifically teaches doping the source regions (region C) with phosphorous and arsenic, removing the 585 mask, and then performing a source and drain arsenic implant. Col. 3, lines 4-21. Clearly, the source regions of Colabella are doped at a

different time than the drain regions, have unequal dopant types and concentrations than the drain regions, and have a depth deeper than the drain regions. See FIG. 4. Takahashi et al., however, stipulate that regions 8, 9, and 10 are doped at the same time such that they have an equal dopant concentration, such that they are formed symmetrically. See col. 21, lines 56-61. Accordingly, one skilled in the art reading Takahashi et al. as a whole would not employ the SAS procedure of Colabella (col. 5, lines 22-44), as alleged by the examiner, as the two references teach away from each other.

Furthermore, Takahashi et al. purport to having no leakage current since the source lines are provided electrically independently in parallel to the respective bit lines. See, e.g., col. 26, lines 47-51. Therefore, unlike it has been suggested by the examiner as the reason for motivation, one skilled in the art would not modify the device of Takahashi et al. with the SAS of Colabella to make leakage current less likely when the device of Takahashi et al. has no leakage current. It would be counterintuitive for one skilled in the art to provide such a feature in order to take care of a non-problem. In view of the above remarks and the clear teaching away, there is no motivation to combine these references.

Applicants also note that there is no motivation to provide the phosphorous-doped oxide spacer of Wu to Takahashi et al. as suggested by the examiner. Wu provides the spacers to serve as a diffusion source to form the extended source and drain junction 24 for the minimum junction depth requirement. See col. 3, lines 7-11. Wu neither discloses nor suggests that forming such extended source and drain junctions with such a diffusion source for providing a minimum junction depth would benefit a FN-FN type EEPROM or even address any of the problems facing Takahashi et al. Takahashi et al. is silent on addressing problems of electrode sheet resistance and source/drain resistance, or the desire to provide extended source and drain junctions for a minimum junction depth. This is because Takahashi et al. explicitly teach that diffusion layers 8, 9, and 10 have an equal dopant concentration and the same depth such that the source and rain regions are formed symmetrically. Accordingly, as the source and drains regions 8 and 9 of Takahashi et al. are separated by immediate region 10, it is unknown what effect extending such source drain regions under their respective transistor as taught by Wu would have on the device of Takahashi et al. None of the cited references purport that such a modification would be successful. Furthermore, no where in Takahashi et al. is the desire to suppress or

address gate induced drain leakage mentioned. Although this may be a desire in Wu, without more evidence to bring together of such elements, regardless of how old and notorious the individual features may be, no case of prima facie obviousness can be established.

Regarding claim 5, Bergement et al. is cited for teaching that the second polysilicon layer in a gate stack can be a wordline. Accordingly, Bergemont et al. fails to cure the above noted deficiencies in Takahashi et al., Colabella, and Wu.

As there is no "clear and particular" reason for the suggested combination of cited references in order to arrive at the recited subject matter of claims 1-5 in view of whole teachings of Takahashi et al., Colabella, and Wu, it follows that the examiner's rejections of claims 1-5 under 35 U.S.C. § 103 should be withdrawn.

Claim 6 is rejected as being unpatentable over Colabella in view of Wu and Rodder (US 6,239,225). Claim 7 is rejected as being unpatentable over Colabella in view of Wu and Rodder, as applied to claim 6, and further in view of Liu et al. (US 6,094,984) and Sobek et al. (US 6,268,624). Claim 19 is rejected as being unpatentable over Colabella in view of Wu. Claim 20 is rejected as being unpatentable over Colabella in view of Wu, Liu et al. and Sobek et al. The applicants respectfully traverse these rejections for the following reasons.

As mentioned previously, Colabella is addressing the problem of the leakage current 15 flowing beneath the bit line between the source line 10 and the drain line 17. See Fig. 2B. Colabella asserts that their SASFOX process lowers the likelihood of current leaking into the bit line region (G) over the field oxide, by providing for an increased physical channel length (Lpar) while leaving the effective channel length (Leff) unchanged. See col. 6, lines 1-4. Colabella also provides a phosphorous dopant only to the source region. See col. 5, line 52-56. Wu on the other hand, shortens the physical channel length (Lpar) by using the sidewall spacers to extend the source and drain region into shallow phosphorous doped regions under the spacers to improve the short channel effect. Col. 5, lines 1-3. Accordingly, combining these references as suggested by the examiner would render Colabella inoperable for its intended purpose by shorting both Lpar and Leff, which is counter to the above noted teaching of Colabella. As these references teach away from each other, one skilled in the art would not combined the references as suggested by the examiner.

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Furthermore, even if these reference were combined, there is no indication that this combination would likely be successful. For example, it is unknown what effect substituting the isolation spacers 12 of Colabella with the phosphorous doped spacers of Wu. Doing so would most likely change the diffusion profile in the source and drain regions, possibly rendering the device of Colabella inoperable as Colabella teaches that as the length of Leff decreases (as would be the case if applying the teachings of Wu), the number of device that fail increases due to a leakage current flowing beneath the bit line between the source line and the drain line. See col. 3, line 50-54.

Rodder is cited for disclosing a re-oxidation profile, and therefore does not cure the above noted deficiencies and dissimilar teachings of Colabella and Wu. Again, the only possible suggestion for modifying the device of Colabella in the manner proposed by the examiner to arrive at the recited subject matter of claims 6 and 19 in view of Wu and Rodder, is hindsight knowledge derived from the applicants' own disclosure. It follows that the examiner's rejections of claims 6 and 19 under 35 U.S.C. § 103 should be withdrawn.

Regarding claims 7 and 20, Sobek et al. is cited for teaching that the re-oxidation process results in inter layer encroachment and the development of a cuspate structure characterized by a "height" and a "width." Liu et al. is cited for teaching that PSG films are porous and highly hydroscopic, depending on the phosphorous concentration. Accordingly, none of these cited reference cure the above noted deficiencies in regards to Colabella and Wu. Accordingly, withdrawal of the rejections to claims 7 and 20 is also requested.

Claim 13 is rejected as being unpatentable over Riedel (US 6,732,241) in view of Colabella, Wu and **Han et al.** [?]. The applicants respectfully traverse these rejections for the following reasons.

Han et al. is once again cited against the recited invention but neither was the reference provided by the applicant in an information disclosure statement nor was a patent number listed on the Examiner's Reference Sheet. The examiner is requested to forward the reference such that it may be considered in another non-final office action.

As stated above, the only possible suggestion for modifying the device of Colabella in the manner proposed by the examiner to arrive at the recited subject matter of original claim 13 in view of Wu, in view of their opposed teachings is hindsight knowledge derived from the

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applicants' own disclosure. Therefore, it follows that claim 13 as presented is allowable over the cited art.

New claim

New claim 21 is directed to another embodiment not previously noted by the applicants, and for which protection is desired. Claim 21 is believed allowable over the cited art.

Conclusion

The applicants believe that all claims are now in condition for allowance. The examiner is encouraged to contact the undersigned to resolve efficiently any formal matters or to discuss any aspects of the application or of this response.

Respectfully submitted,
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